Cover

Federal Agency and Organization Element to Which Report is Submitted:	4900
Federal Grant or Other Identifying Number Assigned by Agency:	0949324
Project Title:	Collaborative Research: Nutrient co-limitation in young and mature northern hardwood forests
PD/PI Name:	Ruth D Yanai, Principal Investigator
Recipient Organization:	SUNY College of Environmental Science and Forestry
Project/Grant Period:	07/01/2010 - 06/30/2016
Reporting Period:	07/01/2014 - 06/30/2015
Submitting Official (if other than PD\PI):	Ruth D Yanai Principal Investigator
Submission Date:	07/06/2015
Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions)	Ruth D Yanai

Accomplishments

*** What are the major goals of the project?**

The major goal of the project is to conduct research on co-limitation by N and P in young and old northern hardwood stands. This is the lead piece of a collaborative project, and our partners will report their goals and accomplishments separately. An important goal of the project is to continue to provide the infrastructure for these and other researchers to conduct research on ecosystem nutrient cycling using our sites.

*** What was accomplished under these goals (you must provide information for at least one of the 4 categories below)?**

Major Activities: Nutrient additions began in 2011 and continue every year. Routine measurements include leaf litter collection and soil respiration measurements. Collaborators are involved in monitoring plant and soil responses. This year, anticipating that we might begin to measure treatment effects, we conducted new measurements in some of the young stands at Bartlett in which soil respiration showed a significant treatment effect. Young stands might be expected to be more responsive to treatment than mature stands. These measurements included stand inventory, root biomass, nutrient uptake (measured in situ on intact roots), mycorrhizal colonization and identification, nutrient concentrations in leaves and leaf litter, and foliar nutrient resorption.

Specific Objectives:

Significant Results:

Foliar resorption is one way to examine the effects of soil nutrient availability on element concentrations within the plant. During the resorption process, foliar nutrients are translocated prior to leaf abscission and stored in other plant tissues; in this way, nutrients are conserved within the plant, reducing nutrient loss in litter and permitting nutrient reuse by other tissues. Resorption is often measured in terms of efficiency (the percent difference between nutrient concentrations of litterfall and green leaves) and proficiency (the concentration to which nutrients have been reduced in litter).

Resource demand and acquisition depend upon many factors, including age, genetic potential, successional stage, and life history strategy. Species effects were significant, and reflective of differences in life history strategies; red maple generally had lowest green leaf and litter concentrations for every element, while pin cherry, an early successional pioneer adapted to rapid growth in fertile soils, tended to have the highest.

Green leaf N concentrations were highest in plots fertilized with N, and lowest in plots fertilized with P (Fig. 5). It is possible that, with more soil P available, trees used more N to construct P-acquiring enzymes. Sampled trees were more proficient and efficient at N resorption in plots fertilized with P (alone or with N), suggesting a co-limitation (Fig. 1). There was a medium correlation between N efficiency and S efficiency (Table 1).

Aluminum is not essential to plants, but is the most abundant metal in the earth's crust. Availability of soluble Al greatly increases below pH 5.0; fertilization increases soil acidity, thus mobilizing Al cations. Higher availability of Al may reduce availability of elements like P, S, and Ca through formation of nearly insoluble compounds. Aluminum resorption efficiency was strongly correlated with green leaf S concentrations; it is possible that a higher concentration of S in green leaves gave Al the opportunity to form Al-S compounds to be resorbed. Availability of other cations may also be reduced through competition with Al cations. Green leaf Al concentrations were lowest in control plots, and highest in NP and P plots. Trees in control plot were most proficient at resorbing Al, and the most Al was retained in senescing leaves in the Ca plot. An increase in available Ca cations may have out-competed Al cations during resorption. Similarly, proficiency of K was lowest in the Ca plot, and litter K and litter Al concentrations were strongly correlated.

Green leaf Ca concentrations varied significantly by treatment. Strangely, Ca concentrations were higher in green leaves in plots fertilized with either N or P, yet lowest in the NP plot. Ca resorption proficiency was highest in plots fertilized with N, and green leaf Ca concentrations were correlated with N efficiency, which may relate to Ca's role in enzyme function and nitrate uptake and metabolism. Green leaf N and Ca concentrations were also positively correlated. Green leaf P concentrations were negatively correlated with Ca resorption efficiency and proficiency.

Green leaf P concentrations varied significantly by treatment, with trees able to accumulate more P in leaves when N and P were added together. Trees were significantly less proficient at P resorption in P-fertilized plots, and most proficient in N-fertilized plots (Fig. 2). There was a weak negative correlation between litter N and green leaf P, and between litter P and green leaf N. To wit, more P in green leaves meant better N proficiency. Trees in the N-fertilized plot were more efficient at P resorption, and litter N concentrations were strongly correlated with P efficiency (Fig. 4 and 5). That is, trees were more efficient at resorbing P at the same time

that they were less proficient at resorbing N. Green leaf P concentrations were correlated with N efficiency, and P efficiency was strongly correlated with both green leaf N and S concentrations (Fig. 3, Table 1). P is key in a variety of plant cell processes; it is also a structural component of proteins, enzymes, and nucleic acids, as are N and S.

Sulfur is involved in many of the same structures and functions as N: it is a building block of proteins, including various enzymes, and is required for production of chlorophyll and conversion of inorganic N into protein. Green leaf and litter S concentrations were significantly higher in N-fertilized plots. S resorption was more proficient and efficient in plots amended with P. Green leaf S concentrations were negatively and strongly correlated with litter P concentrations, and green leaf P concentrations were negatively and strongly correlated with litter S concentrations. In other words, P proficiency was higher with higher green leaf S concentrations, and vice versa. S efficiency was also strongly correlated with green leaf N and P concentrations (Table 1).

Key outcomes or Other achievements:

*** What opportunities for training and professional development has the project provided?**

Training and development occur through interactions among PIs and senior scientists, science teachers, post-docs, graduate students, undergraduates and technicians. Weekly conference calls allow PIs and students to discuss results and future plans, and Google documents and email are used to monitor progress and solicit input on specific topics. Weekly Science Nights with visiting speakers, alternating between the dormitories at Bartlett and Hubbard Brook, remain a feature during the summer field season. Each undergraduate and graduate student has a mentor or a committee of mentors who review proposals and consult on implementation of projects. Most of our students, including the summer crew, have presented talks at the annual HBES Cooperators' Meeting. Summer crew participants have also presented their final reports jointly with REU students from Hubbard Brook. We are expanding our activities with high school students. Four students were involved in field activities in New Hampshire and 14 were involved in laboratory activities in Syracuse. Of those most involved in 2014-2015, 6 were European Americans, 4 African Americans, 2 Asian Americans, and 2 of mixed race, hailing from 2 city schools, 2 suburban schools, and 1 independent school.

*** How have the results been disseminated to communities of interest?**

Journal publications, conferences and websites. (as detailed below)

*** What do you plan to do during the next reporting period to accomplish the goals?**

Nutrient additions will continue along with monitoring plant and microbial responses to treatments. Several manuscripts are in preparation. At least two new graduate students will join the project.

Supporting Files

Filename	Description	Uploaded By	Uploaded On
NSF figures.pdf	Figures and table to accompany Signficiant Results	Ruth Yanai	07/06/2015

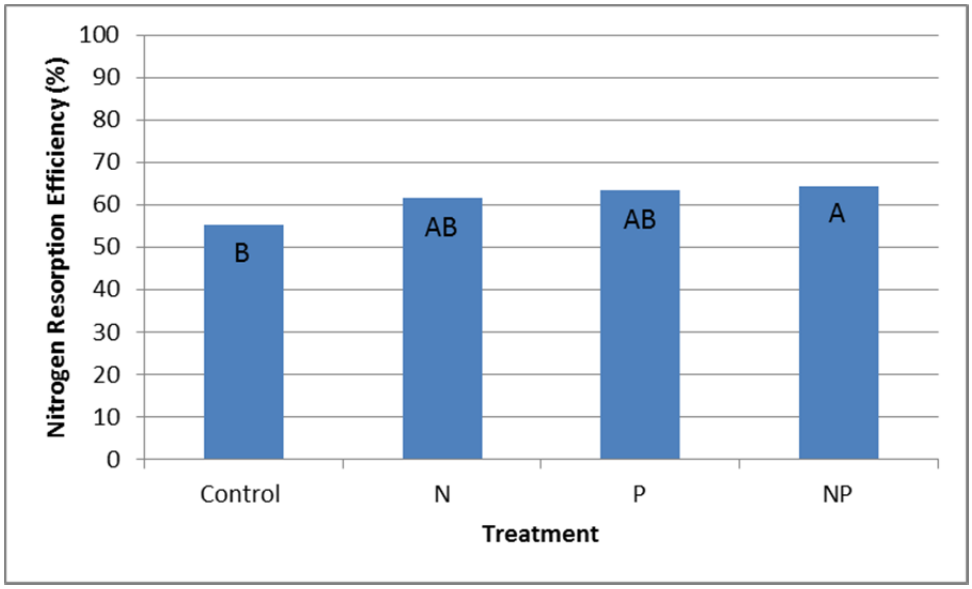

Figure 1. Nitrogen resorption efficiency by treatment. Stand C2 is the experimental unit; the sampling unit is an individual tree. Five species were sampled with three replications for green leaves and one for litter. Trees were significantly more efficient at N resorption in plots fertilized with N and P together (p = .034). Bars with different letters are significantly different.

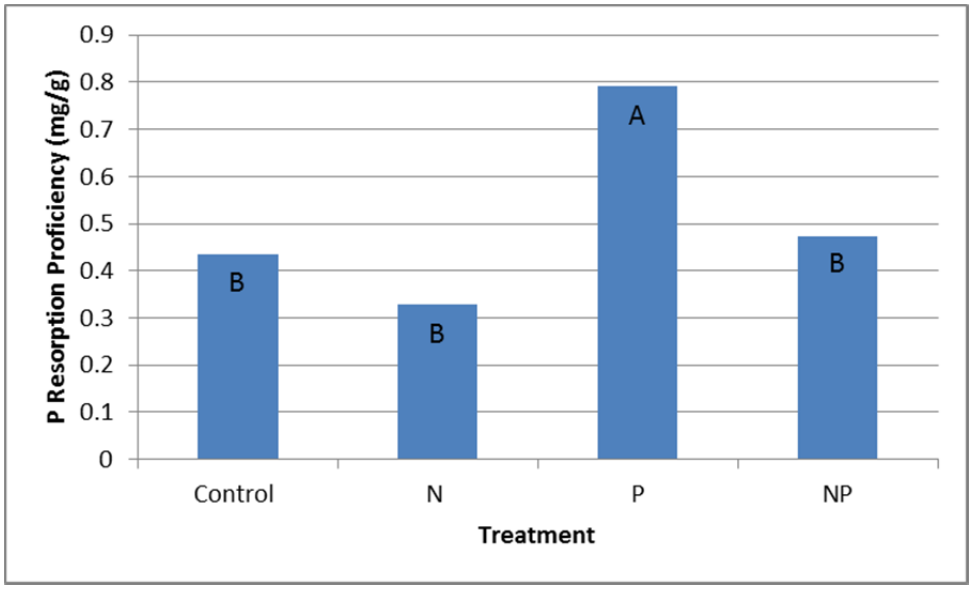

Figure 2. October phosphorus resorption proficiency treatment. The experimental design is a randomized complete block design, with the ANOVA model blocked by stand (C1, C2, and C3). There was a significant difference in P proficiency by treatment, with trees most proficient in N-fertilized plots, and least proficient in P-fertilized plots (p = <0.0001).

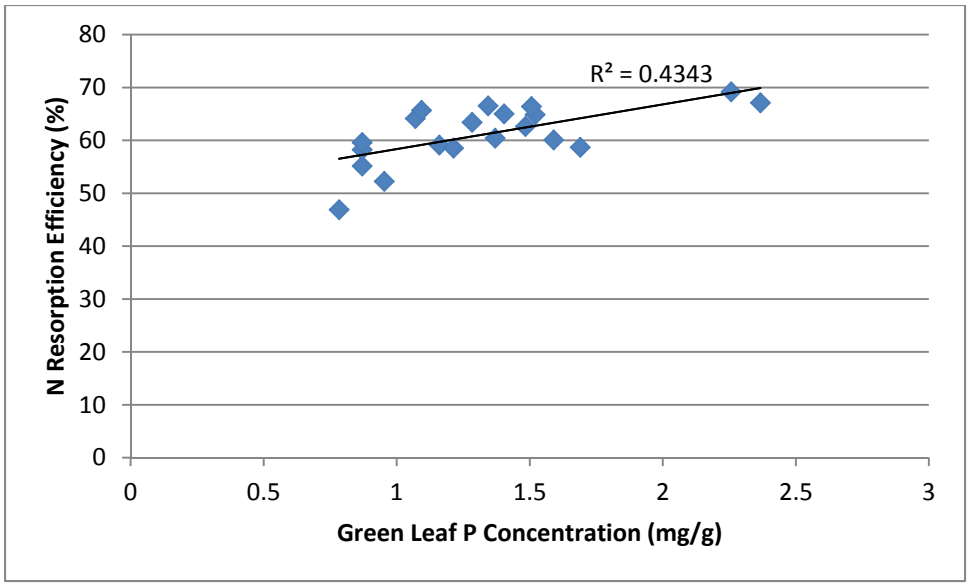

Figure 3. Across all treatments, nitrogen efficiency was significantly and positively correlated with green leaf P concentration ($p = 0.03$). Efficiency improved with higher green leaf P concentrations.

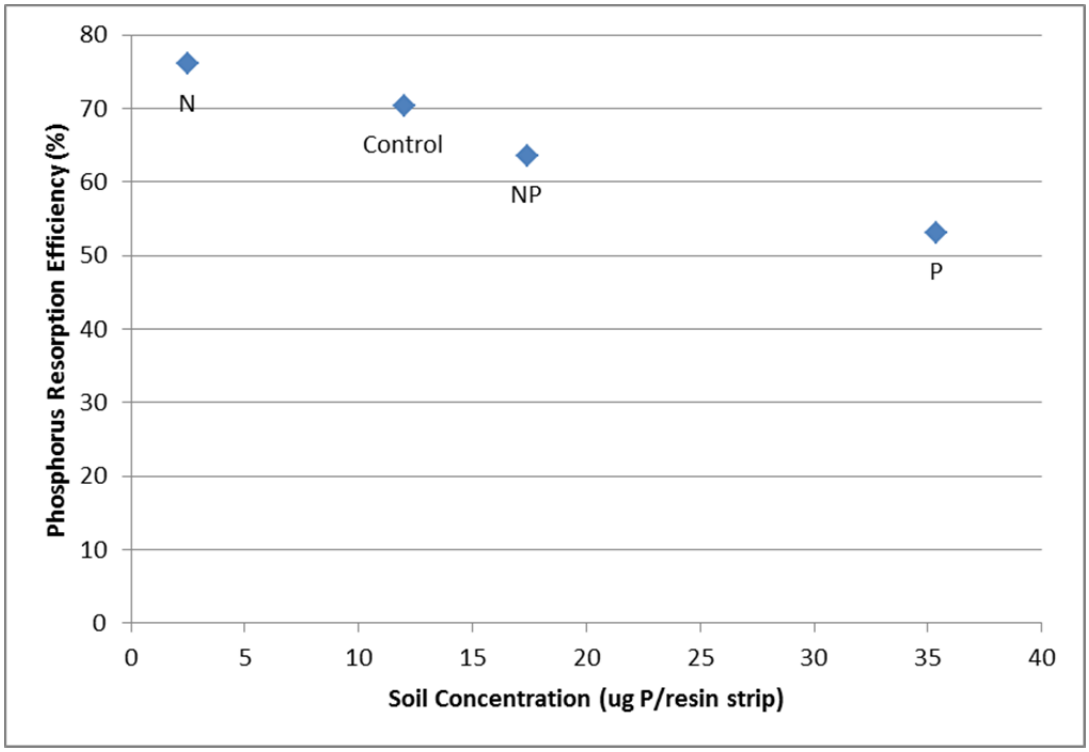

Figure 4. Across all species, phosphorus resorption efficiency decreased with increasing soil P concentrations. Phosphorus resorption efficiency was significantly higher in the N-fertilized plot ($p = 0.05$).

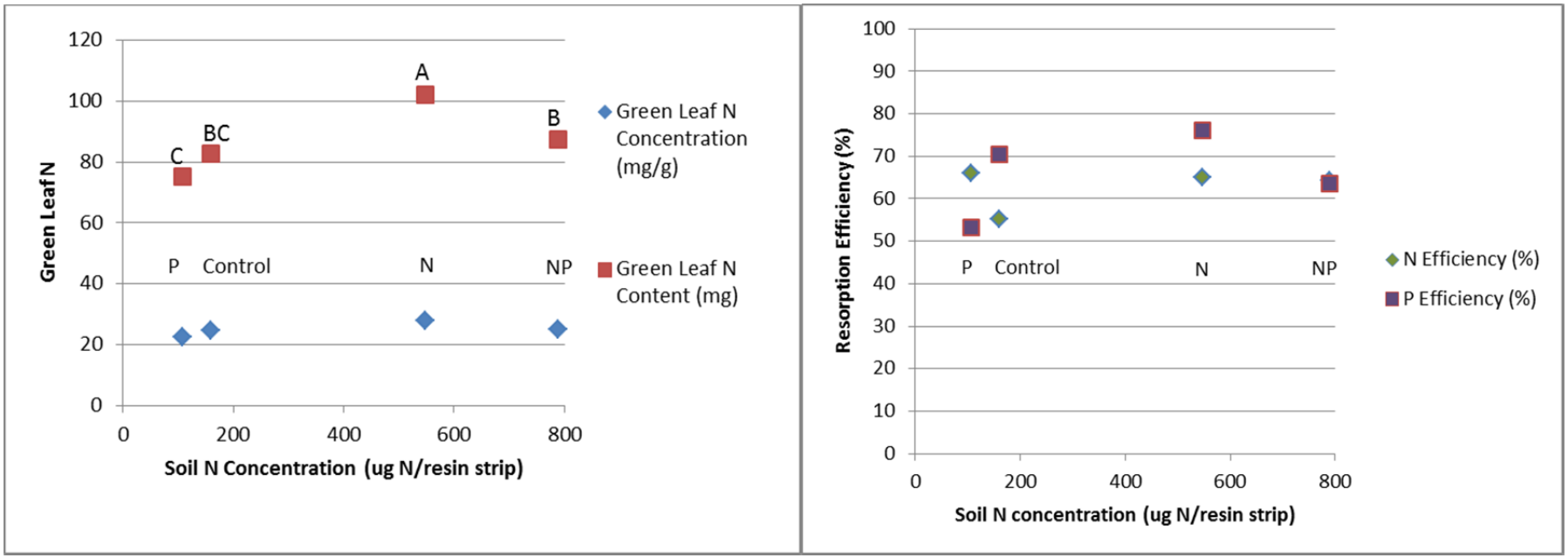

Figure 5. Green leaf N content, green leaf N concentration, and phosphorus efficiency were significantly highest in the N-fertilized plot ($p = <0.05$), yet soil N concentrations were highest in the plot fertilized with N and P together. Nitrogen resorption efficiency was significantly higher in the P-fertilized plot, which also had the lowest soil and green leaf N concentrations ($p = <0.035$).

Table 1. Pearson correlation coefficients for N, P, and S resorption efficiency and green leaf concentrations. Nitrogen efficiency was correlated with green leaf P concentrations, but not with green leaf N concentrations. Phosphorus efficiency did not depend on green leaf P concentrations, but was correlated with green leaf N and S concentrations.

	Resorption Efficiency		
Green Leaf Concentrations	Nitrogen	Phosphorus	Sulfur
Nitrogen	ρ = 0.188 p = 0.427	**ρ = 0.536** **p = 0.018**	**ρ = 0.622** **p = 0.004**
Phosphorus	**ρ = 0.475** **p = 0.034**	ρ = -0.142 p = 0.561	**ρ = 0.651** **p = 0.003**
Sulfur	ρ = 0.138 p = 0.561	**ρ = 0.543** **p = 0.016**	**ρ = 0.470** **p = 0.042**

Products

Books

Book Chapters

Conference Papers and Presentations

Yang,Y., R.D. Yanai, and R.D. Briggs (2014). *Detecting differences of tissue chemistry in four northern hardwoods tree species*. Ecological Society of America Annual Meeting. Sacramento, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Wild, A.D., and R.D. Yanai. (2014). *Do soil nutrients make maple sap sweeter?*. Ecological Society of America Annual Meeting. Sacramento, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

See, C.R., M.C. Fisk, R.D. Yanai (2014). *Nitrogen and phosphorus co-limitation in northern hardwood forests*. Ecological Society of America Annual Meeting. Sacramento, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Yanai, R. (2014). *P-recycling and P-efficiency of ecosystems.*. German Research Foundation's (DRG) Priority Research Programme SPP 1685 workshop "Ecosystem Nutrition: Forest Strategies for limited phosphorus resources", hosted by the Soil Ecology Group at the University of Freiberg, September 17, 2014 ,. Freising, Munich, Germany-. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Dong, Y., R.D. Yanai, M.C. Fisk, R. Briggs, M. Johnston (2014). *Parent material, N cycling, and foliar chemistry in northern hardwood forests*. Ecological Society of America Annual Meeting. Sacramento, CA. Status = PUBLISHED; Acknowledgement of Federal Support = No

Yanai, R.D., Steven Hamburg, Matt Vadeboncoeur; Joel Blum, Mary Arthur, Paul Lilly (2014). *Sustainable Forest Harvest Requires Nutrient Supply from Soil Pools: Ecosystem Budgets for Second-Growth Northern Hardwoods in New Hampshire, USA*. 24th IUFRO World Congress. Salt Lake City, UT. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Yanai, P.J. Lilly, M.A. Arthur, K. Bae, S.P. Hamburg, C.R. Levine, M.A. Vadeboncoeur (2014). *Uncertainty in accounting for carbon accumulation following forest harvesting*. American Geophysical Union Fall Meeting. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Inventions

Journals

Bae, K., T.J. Fahey, R.D. Yanai, and M.C. Fisk. . In press. Acknowledgement of federal support? Yes. Peer Reviewed: Yes. (). Soil nitrogen availability affects belowground carbon allocation and soil respiration in northern hardwood forests of New Hampshire.. *Ecosystems*. . Status = ACCEPTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Fisk, M, S Santangelo, and K Minick (2015). Carbon mineralization is promoted by phosphorus and reduced by nitrogen addition in the organic horizon of northern hardwood forests.. *Soil Biology & Biochemistry*. 81 212. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1016/j.soilbio.2014.11.022

See, Craig R., R.D. Yanai, and M.A. Vadeboncoeur (). Foliar phosphorus resorption increases with soil nitrogen: evidence of nutrient co-limitation in northern

hardwoods. *Ecology*. . Status = AWAITING_PUBLICATION; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Vadeboncoeur, MA, Hamburg SP, Yanai RD, Blum JD. (2014). Rates of sustainable forest harvest depend on rotation length and weathering of soil minerals. *Forest Ecology and Management*. 318 194. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1016/j.foreco.2014.01.012

Wild, A.D., and R.D. Yanai. (2015). Soil nutrients affect sweetness of sugar maple sap.. *Forest Ecology and Management*. 341 30. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1016/j.foreco.2014.12.022

Yanai, R.D., C.A. Blodgett, K. Bae, and B.B. Park. (). Nutrient concentrations of roots vary with diameter, depth, and site in New Hampshire northern hardwoods.. *Journal of Forest Research*. . Status = OTHER; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Licenses

Other Products

Physical Collections.

Many samples with long-term value are stored at SUNY-ESF and tracked through a system developed by the Soil Fertility Laboratory. Samples in active use are at many locations, which are tracked using Google docs.

Data are shared among cooperators via http://www.esf.edu/melnhe

Other Publications

Patents

Technologies or Techniques

Thesis/Dissertations

Bae, Kikang. *Belowground Carbon Fluxes in Response to Nutrient Availability in a Northern Hardwood Forest*. (2013). SUNY College of Environmental Science and Forestry. Acknowledgement of Federal Support = Yes

Diggs, Franklin D.. *Contrasting Mycorrhizal Guilds through the Soil Profile.*. (2014). UNY College of Environmental Science and Forestry. Syracuse,. Acknowledgement of Federal Support = Yes

Yang, Yang.. *Detecting changes in tree tissue chemistry over time in Northern Hardwood Stands.*. (2015). SUNY College of Environmental Science and Forestry. Syracuse. Acknowledgement of Federal Support = Yes

Dong, Yi.. *Effects of rock-derived nutrients on N cycling in northern hardwood forest.*. (2014). SUNY College of Environmental Science and Forestry. Syracuse. Acknowledgement of Federal Support = No

See, Craig R.. *Foliar resorption in a northern hardwood forest*. (2013). SUNY College of Environmental Science and Forestry. Acknowledgement of Federal Support = Yes

Vadeboncoeur, Matthew A. *Mechanisms of nutrient limitation and nutrient acquisition in managed and unmanaged forest ecosystems*. (2013). University of New Hampshire. Acknowledgement of Federal Support = Yes

Wild, Adam D.. *Soil Nutrients Affect Sweetness of Sugar Maple Sap*. (2014). SUNY College of Environmental Science and Forestry. Acknowledgement of Federal Support = Yes

Websites

Multiple Element Limitation in Northern Hardwood Ecosystems
http://www.esf.edu/melnhe

We use the MELNHE website to provide news briefs about the project to any interested party and to share data, photos, and documentation among collaborators, using a password-protected section.

Participants/Organizations

Research Experience for Undergraduates (REU) funding

Form of REU funding support:	REU supplement
How many REU applications were received during this reporting period?	28
How many REU applicants were selected and agreed to participate during this reporting period?	2
REU Comments:	

What individuals have worked on the project?

Name	Most Senior Project Role	Nearest Person Month Worked
Yanai, Ruth	PD/PI	1
Garrison-Johnston, Mariann	Faculty	1
Engelman, Heather	Technician	1
Lee, Raymond	Technician	2
Wild, Adam	Technician	2
Barner, Jerome	Graduate Student (research assistant)	3
Campell, Theo	Undergraduate Student	0

Kuhn, Alex	Undergraduate Student	1
Bility, Mariam	High School Student	1
Carper, Lisa	High School Student	1
Dayton, Abby	High School Student	1
Kenneh, Materjay	High School Student	1
Sheehan, Hank	High School Student	0
Walsh, Griffin	High School Student	2
Smith, Gabriel	Research Experience for Undergraduates (REU) Participant	1
Turlip, Justin	Research Experience for Undergraduates (REU) Participant	3
Phelps, Kara	Other	1

Full details of individuals who have worked on the project:

Ruth D Yanai
Email: rdyanai@syr.edu
Most Senior Project Role: PD/PI
Nearest Person Month Worked: 1

Contribution to the Project: Dr. Yanai coordinates the project, oversees study design, staff and students, and coordinates communication among collaborators.

Funding Support: Salary, State of New York, SUNY College of Environmental Science and Forestry. Participation in SPP 1685 workshop (see foreign travel, below) German Research Foundation (DFG)

International Collaboration: No
International Travel: Yes, Germany - 0 years, 0 months, 3 days

Mariann Garrison-Johnston
Email: mjohnston@esf.edu
Most Senior Project Role: Faculty
Nearest Person Month Worked: 1

Contribution to the Project: Dr. Johnston has been involved in a study of beech bark disease and has a “satellite” fertilization study in Wanakena, NY.

Funding Support: State of New York, SUNY College of Environmental Science and Forestry

International Collaboration: No
International Travel: No

Heather Engelman
Email: forestecology@esf.edu
Most Senior Project Role: Technician
Nearest Person Month Worked: 1

Contribution to the Project: Heather provides administrative support for the project, including preparation of reports and maintenance of www.esf.edu/melnhe

Funding Support: Heather also worked part-time on another NSF project, and was supported by it. She also has a small FTE state position.

International Collaboration: No
International Travel: No

Raymond Lee
Email: raymondmarklee@gmail.com
Most Senior Project Role: Technician
Nearest Person Month Worked: 2

Contribution to the Project: Summer field activities.

Funding Support: None

International Collaboration: No
International Travel: No

Adam D Wild
Email: adamdwild@gmail.com

Most Senior Project Role: Technician
Nearest Person Month Worked: 2

Contribution to the Project: Adam led the summer field crew, and continued part-time documenting data.

Funding Support: None.

International Collaboration: No
International Travel: No

Jerome Barner
Email: jeromebarneriii@gmail.com
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 3

Contribution to the Project: Jerome was involved with summer field activities in 2014 and will lead the summer crew 2015. He is conducting MS research.

Funding Support: He also had a TA between appointments and will be beginning a Sussman Internship.

International Collaboration: No
International Travel: No

Theo Campell
Email: tjcamp01@syr.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 0

Contribution to the Project: Senior, ESF. Arthropods, for ESF independent study project.

Funding Support: None.

International Collaboration: No
International Travel: No

Alex Kuhn
Email: alexkuhn1123@gmail.com
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 1

Contribution to the Project: Senior, ESF. Worked in the field and the lab, primarily on AM and EM mycorrhizal fungi.

Funding Support: None.

International Collaboration: No
International Travel: No

Mariam Bility
Email: mariambility56@yahoo.com
Most Senior Project Role: High School Student
Nearest Person Month Worked: 1

Contribution to the Project: Mariam is a sophomore at Central Tech, Syracuse City School District. She helped process samples and data in Syracuse.

Funding Support: None.

International Collaboration: No
International Travel: No

Lisa Carper
Email: lisacarper89@gmail.com
Most Senior Project Role: High School Student
Nearest Person Month Worked: 1

Contribution to the Project: Senior, Kennett High School, N. Conway, NH. Lisa helped with summer field collections, to complement work she was doing in her school science classes.

Funding Support: None.

International Collaboration: No
International Travel: No

Abby Dayton
Email: abbyrd97@gmail.com
Most Senior Project Role: High School Student
Nearest Person Month Worked: 1

Contribution to the Project: Abby is a senior at Manlius-Pebble Hill School, Dewitt, NY. In addition to lab work in Syracuse, she was involved in snail collections in New Hampshire and used this project for her Senior Thesis.

Funding Support: None.

International Collaboration: No
International Travel: No

Materjay Kenneh
Email: materjaykenneh@yahoo.com
Most Senior Project Role: High School Student
Nearest Person Month Worked: 1

Contribution to the Project: Materjay is a senior at Nottingham High School, Syracuse City School District. She helped process samples and data in Syracuse.

Funding Support: None.

International Collaboration: No
International Travel: No

Hank Sheehan
Email: hanksheehan@gmail.com
Most Senior Project Role: High School Student
Nearest Person Month Worked: 0

Contribution to the Project: Senior, Manlius-Pebble Hill School, Dewitt, NY. He helped process samples and data in Syracuse.

Funding Support: None.

International Collaboration: No
International Travel: No

Griffin Walsh
Email: gwalsh@mph.net
Most Senior Project Role: High School Student
Nearest Person Month Worked: 2

Contribution to the Project: Senior, Manlius-Pebble Hill School, Dewitt, NY. He was involved in both field and lab work and will be working with high school students as a Research Analyst this summer (see next year's report).

Funding Support: None.

International Collaboration: No
International Travel: No

Gabriel Smith
Email: gsmith01@syr.edu
Most Senior Project Role: Research Experience for Undergraduates (REU) Participant
Nearest Person Month Worked: 1

Contribution to the Project: Senior, ESF. He led the organization of samples and analysis of data for roots from soil cores.

Funding Support: He was an hourly Research Aide on the "main" part of this award for the early part of the reporting period, but finished the year as a REU.

International Collaboration: No
International Travel: No
Year of schooling completed: Junior
Home Institution: SUNY ESF
Government fiscal year(s) was this REU participant supported: 2015

Justin Turlip
Email: justinturlip@gmail.com
Most Senior Project Role: Research Experience for Undergraduates (REU) Participant
Nearest Person Month Worked: 3

Contribution to the Project: Justin joined us between his junior and senior years at NYU, where he is working toward a BS in Environmental Science, with dual minors in Biology (Ecology Track) and Web Programming and Applications His project was entitled: Does wollastonite make the soil drier?

Funding Support: Cornell University for 2 weeks.

International Collaboration: No
International Travel: No
Year of schooling completed: Junior
Home Institution: New York University
Government fiscal year(s) was this REU participant supported: 2014

Kara Elizabeth Phelps
Email: kephelps@syr.edu
Most Senior Project Role: Other

Nearest Person Month Worked: 1

Contribution to the Project: Joined project as a Senior, ESF, stayed as a graduate student. She processed collected leaves from trees of five species to address nutrient resorption.

Funding Support: State Graduate Assistant.

International Collaboration: No
International Travel: No

What other organizations have been involved as partners?

Name	Type of Partner Organization	Location
A. Crosby Kennett Middle School	Academic Institution	Conway, NH
Cornell University	Academic Institution	Ithaca, NY
Hubbard Brook Research Foundation	Other Nonprofits	North Woodstock, NH
Marine Biological Laboratory	Academic Institution	Woods Hole, MA
Miami University	Academic Institution	Oxford, OH
USDA Forest Service - Northern Forest Experiment Station	Other Organizations (foreign or domestic)	Bartlett, NH
University of Michigan	Academic Institution	Ann Arbor, MI

Full details of organizations that have been involved as partners:

A. Crosby Kennett Middle School

Organization Type: Academic Institution
Organization Location: Conway, NH

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution: teachers have been working with collaborators to incorporate age-appropriate investigations of the sites in their

middle school science classrooms.

Cornell University

Organization Type: Academic Institution
Organization Location: Ithaca, NY

Partner's Contribution to the Project:
Financial support
In-Kind Support
Facilities
Collaborative Research
Personnel Exchanges

More Detail on Partner and Contribution: This project was established as, and continues to be, Collaborative Research with Principal Investigators housed at each institution.

Hubbard Brook Research Foundation

Organization Type: Other Nonprofits
Organization Location: North Woodstock, NH

Partner's Contribution to the Project:
Facilities

More Detail on Partner and Contribution:

Marine Biological Laboratory

Organization Type: Academic Institution
Organization Location: Woods Hole, MA

Partner's Contribution to the Project:
Financial support
In-Kind Support
Facilities
Collaborative Research
Personnel Exchanges

More Detail on Partner and Contribution: This project was established as, and continues to be, Collaborative Research with Principal Investigators housed at each institution.

Miami University

Organization Type: Academic Institution
Organization Location: Oxford, OH

Partner's Contribution to the Project:
Financial support
In-Kind Support
Facilities
Collaborative Research
Personnel Exchanges

More Detail on Partner and Contribution: This project was established as, and continues to be, Collaborative Research with Principal Investigators housed at each institution.

USDA Forest Service - Northern Forest Experiment Station

Organization Type: Other Organizations (foreign or domestic)
Organization Location: Bartlett, NH

Partner's Contribution to the Project:
Facilities

More Detail on Partner and Contribution:

University of Michigan

Organization Type: Academic Institution
Organization Location: Ann Arbor, MI

Partner's Contribution to the Project:
Financial support
In-Kind Support
Facilities
Collaborative Research
Personnel Exchanges

More Detail on Partner and Contribution: This project was established as, and continues to be, Collaborative Research with Principal Investigators housed at each institution.

What other collaborators or contacts have been involved?

Other researchers using these sites include:

Mark Green and Michele Pruyn, Plymouth State University

Matt Vadeboncoeur and Heidi Asbjornsen, University of New Hampshire,

Tom Horton and Dylan Parry, SUNY ESF

Impacts

What is the impact on the development of the principal discipline(s) of the project?

We are publishing papers on nutrient interactions in foliar resorption (See et al. 2015), soil nutrient availability (Fisk et al. 2014), and soil respiration (Fahey et al, in preparation).

What is the impact on other disciplines?

Our research includes biological control of mineral weathering (Joel Blum and Melany Fisk are collaborating on an experiment involving apatite in soil ingrowth cores).

What is the impact on the development of human resources?

See Training and Development, under Accomplishments.

What is the impact on physical resources that form infrastructure?

The continuing treatment (control, N, P, N&P, and Ca), and monitoring of plots in thirteen stands distributed over three sites represents a significant contribution to research infrastructure.

What is the impact on institutional resources that form infrastructure?

The project contributes to the HBR LTER.

What is the impact on information resources that form infrastructure?

We contribute data sets to the HBR LTER.

What is the impact on technology transfer?

Our work with maple sap has contributed to Collaborative Research: IDBR: Type A: The NANAPHID: A novel aphid-like nanosens (NSF 1455513). The project is producing a tiny sensor that will measure sugar concentrations (sucrose, glucose, and fructose) in the sap of trees. This gadget is called a “Nanaphid”, as it will function like an aphid in preventing a wound response that would prevent sap monitoring.

What is the impact on society beyond science and technology?

We are contributing to education of high school students as well as undergraduate and graduate students. Our results will inform policy and management.

Changes/Problems

Changes in approach and reason for change

Two of our sites (Jeffers Brook and Hubbard Brook) were not mentioned in the grant proposal. We added stands of two age classes at these two sites to complement the nine stands (three replicates of three age classes) at Bartlett Experimental Forest. One of our treatments (Ca addition) was not in the original proposal but was the subject of an ROA Supplement. The additional sites and treatments have enabled us to test a broader suite of hypotheses than originally envisioned.

Actual or Anticipated problems or delays and actions or plans to resolve them

Nothing to report.

Changes that have a significant impact on expenditures

As previously reported, our first technician left the program, and was never replaced in the same capacity. Instead, we have hired current or recent graduate students to manage the summer field crew, paying them at the rate of a technician rather than at the graduate student rate. This strategy took advantage of personnel already familiar with the project and saves money in fringe benefits. We again had savings associated with a delay in recruiting a graduate student to replace those that have graduated. These accumulated savings will be used during a no-cost extension through June 2016 with the student recruited to begin late summer 2015.

Significant changes in use or care of human subjects

Nothing to report.

Significant changes in use or care of vertebrate animals

Nothing to report.

Significant changes in use or care of biohazards

Nothing to report.